Revue suisse de Zoologie, vol. hors série: 515-522; août 1996

Precopulatory male ethograms of three species of *Lycosa* Latreille 1804 (Araneae: Lycosidae) of the Iberian peninsula

Juan Manuel ORTA-OCAÑA, Jordi MOYA-LARAÑO & José A. BARRIENTOS
Unitat de Zoologia. Departament de Biologia Animal, Biologia Vegetal i Ecologia. Universitat Autònoma de Barcelona. E-08193 Bellaterra (Barcelona), Spain.

Precopulatory male ethograms of three species of *Lycosa* Latreille, 1804 (Araneae: Lycosidae) of the Iberian peninsula. - In order to revise the representatives of the genus Lycosa from the Iberian Peninsula, the courtship behaviour of the males of the three morphotypes was analysed from a total of 46 male-female interactions. The three ethograms presented here are subdivided into four parts: locomotory behaviours, foreleg movements and postures, palpal movements and postures and other behaviours. From the qualitative analysis of the repertoires, several differences in movements and postures can be seen, so we can conclude that the three morphotypes can be considered as three different species. While *L. radiata* shows extensions with vibration, *L. tarentula fasciiventris* shows static extensions and arches. There also are differences in the palpal movements. *Lycosa* sp. shows exclusive behaviours such as flexions, foreleg balance and sudden advances, as well as behaviours also seen in *L. radiata* and *L. tarentula fasciiventris*.

Key-words: *Lycosa tarentula fasciiventris* - *Lycosa radiata* - *Lycosa* sp. - ethogram- courtship - isolation mechanisms - biospecies.

INTRODUCTION

This study is part of a project aiming to revise taxonomically the genus *Lycosa* in the Iberian Peninsula using behavioural and ecological criteria, as well as the classical morphological ones. The representatives of the genus *Lycosa* in the Iberian Peninsula are *Lycosa radiata* Latreille, 1817 and *L. tarentula fasciiventris* Dufour, 1835. Nevertheless, new morphotypes that do not fit into either of these two species have been found.

The genus *Lycosa*, which names the family Lycosidae, comprises 116 species distributed over the hot and temperate regions of the World. Nearly 20 nominal species have been recorded from the Iberian Peninsula, although their biological

Manuscript accepted 08.12.1995.
Proceedings of the XIIIth International Congress of Arachnology, Geneva, 3-8.IX.1995.

entity is questionable. Following BARRIENTOS (1981), we can conclude that only two of them can be considered as biological species: *Lycosa radiata* Latreille, 1817 and *L. tarentula fasciiventris* Dufour, 1835. Nevertheless, new morphotypes (*Lycosa* sp.) have been found that do not fit in any of the accepted forms. So, a revision of the genus is necessary, bearing in mind the species concept in a wider point of view than the one given by taxonomy on its own.

The biological species concept requires the existence of isolation mechanisms to guarantee the existence of separated species. The ethological barriers may be regarded as the most important isolating mechanisms (MAYR 1970). Lycosidae is a morphologically homogeneous group and due to the fact that the species we are studying are syntopic, the ethological mechanisms might explain the speciation processes in the group.

Ethological barriers are due to behavioural incompatibilities. The male of one species performs some courtship patterns that are recognised just by the adequate female. These mechanisms have been observed in a vast group of insects and spiders. The validity of these ethological patterns as isolation mechanisms has already been proved in other *Lycosa* species (COSTA & CAPOSACALE 1984; COSTA & FRANCESCOLI 1991), as well as in many other lycosid species (UETZ & STRATTON (1982), *Schizocosa* spp.) and other families (VLIJM 1986).

MATERIAL AND METHODS

The spiders were collected as juveniles from different populations in the Barcelona area and kept in isolated cages. After becoming adults, male-female pairs were chosen at random and the female put into the observation cage 24h prior the introduction of the corresponding male. Observation cages were made of transparent plastic and consist in two adjacent areas of 15 x 15 cm. separated by a removable opaque barrier. This barrier was removed at the beginning of the experiment. The interactions were recorded on video tape for further analyses.

After 22.5 hours of observation, we constructed three ethograms of the different movements and postures of the three forms. Some of the terms used in the ethograms were taken from the literature (NOSSEK & ROVNER 1984; ASPEY 1977). Within those 22.5 hours, 26 male-female interactions were recorded for *L. radiata* (409 min), 13 interactions for *L. tarentula fasciiventris* (502 min) and 17 for *Lycosa* sp. (440 min).

RESULTS

Due to the fact that there are a lot of details that can be recorded in one interaction, we have divided the ethogram in different subrepertoires, to allow the independence of the categories in each subrepertoire. The categories can overlap between subrepertoires, but not in the same subrepertoire. So, different observers could record different subrepertoires or the same observer could record different

subrepertoires in different video reviewing sessions. At the end of the sessions, it would be possible to obtain a multiple behaviour chart. We have only elaborated the male's premating ethogram, although we are aware of the relevant importance of the female's behaviour, so ethograms should be elaborated for the latter.

1. Locomotory behaviours

Common behaviours

1.1. Stationary: the male remains motionless, with the four pairs of legs in contact with the substrate.

1.2. Approach: the male advances so it reduces the distance between itself and the female.

1.3. Retreat: the male moves away so it increases the distance between itself and the other one. It is assumed that the other spider is stationary. It is possible that the female goes after the male, so there is no actual increase in the distance between them.

1.4. Orientation: the male turns around an imaginary vertical axe so as to end up facing the female.

1.5. Side movement: the male moves towards its right or left side, without displacement forward or backwards.

1.6. Step-Wave: hyperextension of one or typically both legs I and II during forward motion. At the top of the raise, the femora are held at an angle of 40-60° relative to the substrate. Forward motion continues as the forelegs are lowered to the substrate and again hyperextended and raised.

1.7. Random activity: running without an specific orientation.

L. tarentula fasciiventris **exclusive behaviours**

1.8. Side movement around the burrow: similar to the previous category (1.5), but with the burrow as the centre of the side movement.

Lycosa **sp. exclusive behaviours**

1.9. Fast approach: the spider advances very quickly reducing the distance between itself and the female..

2. Foreleg movements and postures

Common behaviours

2.1. Stationary: the leg is in contact with the substrate.

2.2. Horizontal extend (left/right/both): the extended leg is raised and held parallel to the substrate. (fig. 1. a) (not in *L. tarentula fasciiventris*).

2.3. Oblique extend (left/right/both): the leg is extended straight, the femur is held at an angle of 45-60° relative to the substrate. (fig. 1. b)

2.4. Vertical extend (left/right/both): the leg is extended straight and the femur is held at an angle of 60-90° relative to the substrate. (fig. 1. c)

L. radiata exclusive behaviours

In categories 2.2 to 2.4, it is common to observe some vibration of the legs raised. This vibration is not quantified in the ethogram.

2.5. Tapping (left/right/both): the leg is raised straight about 30-40° relative to the substrate and subsequently lowered to contact the substrate, as if it were probing the substrate. It is similar to 2.2 but here the tip of the leg touches the substrate or silk threads (laid by the female). (fig. 1. d)

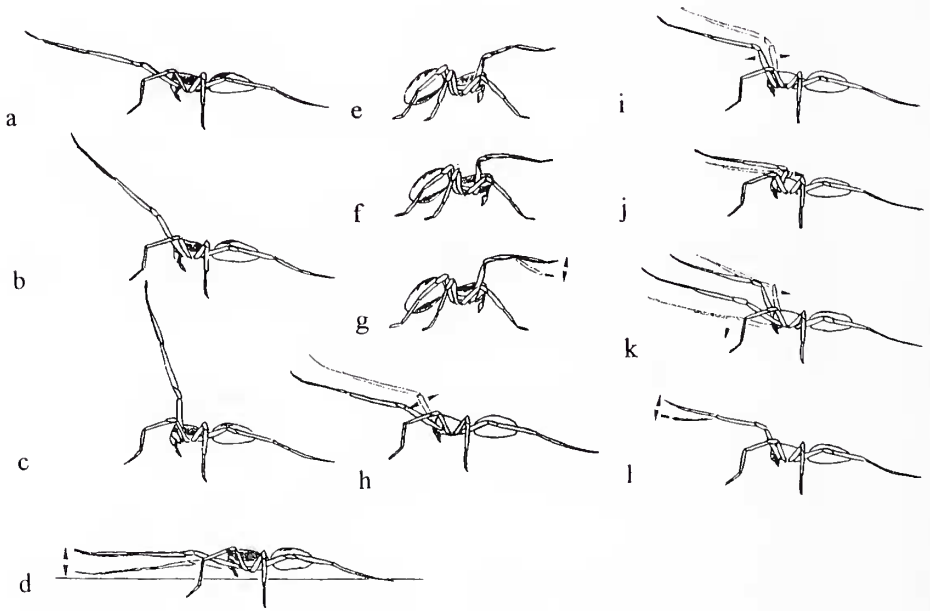

FIG. 1

Foreleg movements and postures: Extends. a.- Horizontal extend (2.2); b.- Oblique extend (2.3); c.- Vertical extend (2.4); d.- Tapping (*L. radiata* exclusive behaviour) (2.5). Exclusive foreleg movements and postures. e.- Vertical arch (2.6); f.- Obtuse arch (2.7); g.- Arch balancing (2.8). *Lycosa* sp. exclusive foreleg movements and postures. h.- Oblique flex (2.9);i.- Vertical flex (2.10); j.- Obtuse flex (2.11); k.- Foreleg balance (2.12); l.- Metatarsal oscillation (2.14). Numbers in brackets refer to the category number in text.

TABLE I

	Locomotory behaviours														Other behaviours				
form / behaviour number	1.1 Stationary	1.2 Approach	1.3 Retreat	1.4 Orientation	1.5 Side movement	1.6 Step-wave	1.7 Random activity	1.8 Side mov. burrow	1.9 Fast approach						4.1 Contact	4.2 Mount	4.3 Retreat	4.4 Mating position	4.5 Female's burrow entry
Lycosa radiata	■	■	■	■	■	■	■								■	■	■	■	
Lycosa tarentula fasciiventris	■	■	■	■	■	■	■	■							■	■	■	■	■
Lycosa sp.	■	■	■	■	■	■	■		■						■	■	■	■	

	Palpal movements					Foreleg movements and postures													
form / behaviour number	3.1 Stationary	3.2 Palpal drumming	3.3 Silk touch	3.4 Palpal drum. on the rim		2.1 Stationary	2.2 Horizontal extend	2.3 Oblique extend	2.4 Vertical extend	2.5 Tapping	2.6 Vertical arch	2.7 Obtuse arch	2.8 Arch balancing	2.9 Oblique flex	2.10 Vertical flex	2.11 Obtuse flex	2.12 Foreleg balancing	2.13 Sudden advance	2.14 Metatarsal oscillation
Lycosa radiata	■	■	■			■	■	■	■	■									
Lycosa tarentula fasciiventris	■	■		■		■		■	■		■	■	■						
Lycosa sp.	■	■				■	■	■	■				■	■	■	■	■	■	■

L. tarentula fasciiventris **exclusive behaviours**

This species doesn't show horizontal extends (category 2.2) Opposite to *L. radiata*, vibration is not observed in categories 2.3 and 2.4.

2.6. Vertical arch (left/right/both): the leg I femur is raised at 60-90° relative to the substrate, and the femoro-patellar joint is flexed, as well as the tibio-metatarsal joint, although this one is less flexed. (fig. 1. e)

2.7. Obtuse arch (left/right/both): the leg I femur is pointing posteriorly at 95-140°. The femoro-patellar joint is flexed, as well as the tibio-metatarsal joint. This category is usually seen when the male is at the female's burrow. (fig. 1. f)

2.8. Arch balancing (left/right/both): the leg is raised in one of the arch categories while is slowly moving up and downwards at the tibio-metatarsal joint. The movement is slow, it is not a vibration movement. (fig. 1. g)

In categories 2.3, 2.4 and 2.6 to 2.8, the most usual is that the spider moves both forelegs.

Lycosa **sp. exclusive behaviours**

In categories 2.2 to 2.4 is not usual to observe vibration. If it occurs, it is short, on the contrary as it happens in *L. radiata*. Illustrations are the same as for *L. radiata*.

2.9. Oblique flex (left/right/both): the leg I femur is raised and held at 45-60° relative to the substrate. The femoro-patellar joint is flexed, as well as the previous joints, while the rest of the leg segments remains parallel to the substrate. (fig. 1. h)

2.10. Vertical flex (left/right/both): the leg I femur is raised and held at 60-90° relative to the substrate. The femoro-patellar joint is flexed, as well as the previous joints, while the rest of the leg segments remain parallel to the substrate. (fig. 1. i)

2.11. Obtuse flex (left/right/both): the leg I femur is raised and held pointing posteriorly at 95-140° relative to the substrate. The femoro-patellar joint is flexed, as well as the previous joints, while the rest of the leg segments remains parallel or in an acute angle to the substrate. (fig. 1. j)

2.12. Foreleg balancing: While one leg is being flexed or extended at the femoro-patellar joint, the other may remain motionless or moving in an opposite way (e.g.: one leg is being extended and the other flexed). (fig. 1. k)

2.13. Sudden advance: while the forelegs are extended or flexed, the spider suddenly jumps forward, while legs II (right/left/both) are raised briefly. A brief vibration of legs is often observed prior to the jump.

2.14. Metatarsal oscillation (right/left/both): a slight oscillation at the tibia-metatarsal joint is performed. It rarely occurs. (fig. 1. l)

3. Palpal movements and postures

Common behaviours

3.1. Stationary: the palps remain motionless, more or less perpendicular to the substrate.

3.2. Palpal drumming: palps alternately lifted and lowered in rapid succession, usually contacting the substrate.

L. radiata **exclusive behaviours**

3.3. Silk touch (left/right/both): the palps touch a silk thread.

L. tarentula fasciiventris **exclusive behaviours**

3.4. Palpal drumming on the rim: the palpal drumming is performed on the rim surrounding the female's burrow.

4. Other behaviours

Common behaviours

4.1. Contact: one spider's foreleg (usually the male's) contacts some part of the body of the other spider.

4.2. Mount: the male climbs over the female's body but does not adopt the mating position (4.4.).

4.3. Retreat: the male moves slightly backwards.

4.4. Mating position: the male places itself in the mating position (type 3, Foelix 1982), although actual copulation may not take place.

L. tarentula fasciiventris **exclusive behaviours**

4.5. Female's burrow entry: the male gets into the female's burrow.

DISCUSSION

In this qualitative study of courtship, we can see several differences among the species. *L. radiata* and *L. tarentula fasciiventris* show clearly different categories in the subrepertoire of leg movements and postures. While *L. radiata* shows extensions with vibration, *L. tarentula fasciiventris* shows static extensions and arches. There are also differences in the palpal movements repertoire, probably associated with other communication channels as acoustic (Uetz & Stratton 1982; Stratton & Uetz 1983) or chemical communication (Tietjen & Rovner 1980, 1982). On the other

hand, *Lycosa* sp. shows behaviours seen in *L. radiata* and *L. tarentula fasciiventris* (extensions and arch balancing), but also exclusive behaviours as flexions, foreleg balancing and sudden advance. The absence/presence of behaviours is summarised in table I. We can conclude, from a qualitative point of view, that we are dealing with a different species. A comprehensive study of the behaviour's variation is needed, as well as carrying out reproductive isolation experiments. Since sequential analyses have not been performed yet, it would be too speculative to state which of the behaviours observed may be the important in the species recognition process, this is, which one transports the signals to the female. Moreover, part of the courtship takes place via non-visual channels that haven't been analysed in the present work.

ACKNOWLEDGEMENTS

We want to thank to Prof. P.J.B. Slater the review of the ethograms.

REFERENCES

ASPEY, W.P. 1977. Wolf Spider Sociobiology: 1. Agonistic Display and Dominance subordinance relations in adult male *Schizocosa crassipes*. *Behaviour* 62:103-141.

BARRIENTOS, J.A. 1981. Discussion preliminaire du genre Lycosa Latr., 1804 dans la Péninsule Ibérique. *Memorie della Società toscana di scienze naturali, ser. B*, 88, suppl.: 204-208.

COSTA, F.G. & CAPOSACALE, R.M. 1984. *Lycosa carbonelli*, sp. nov.: una etoespecie simpátrida, sibilina de *Lycosa thorelli* (Keyserling) (Araneae, Lycosidae). *Journal of Arachnology* 11:423-431.

COSTA, F.G. & FRANCESCOLI, G. 1991. Analyse expérimentale de l'isolement reproductif entre deux espèces jumelles et sympatriques d'araignées: le *Lycosa thorelli* (Keyserling) et le Lycosa carbonelli Costa et Caposacale. *Canadian Journal of Zoology* 69:1768-1776.

FOELIX, R.F. 1982. Biology of Spiders, *Harvard University Press, Cambridge, Mass*. 306 p.

MAYR, E. 1970. Populations, Species, and Evolution. *Harvard University Press. Cambridge, Mass*. 453 pp.

NOSSEK, M.E. & ROVNER, J.S. 1984. Agonistic behavior in female wolf spiders (Araneae, Lycosidae). *Journal of Arachnology* 11:407-422.

STRATTON, G.E. & UETZ, G.W. 1983. Communication via substratum-coupled stridulation and reproductive isolation in wolf spiders (Araneae: Lycosidae). *Animal Behaviour* 31:164-172.

TIETJEN, W.J. & ROVNER, J.S. 1980. Trail-following behavior in two species of wolf spiders: Sensory and ethoecological concomitants. *Animal Behaviour* 28:734-741.

TIETJEN, W.J. & ROVNER, J.S. 1982. Chemical communication in lycosids and other spiders. In: Spider Communication: Mechanisms and Ecological Significance (WITT, P.N.& J.S. ROVNER). *Princeton University Press, Princeton*, 249-279.

UETZ, G.W. & STRATTON, G.E. 1982. Acoustic communication and reproductive isolation in spiders. In: Spider Communication: Mechanisms and Ecological Significance (WITT, P.N.& J.S. ROVNER). *Princeton University Press, Princeton*, 249-279.

VLIJM, L. 1986. Ethoespecies. Behavioral patterns as an interspecific barrier. *Actas X Congreso Internacional de Aracnología, Jaca/España* II: 41-45.